DR. RAJAT DHAR'S RULE 26 REPORT

Washington University in St. Louis
SCHOOL OF MEDICINE
Department of Neurology

February 5, 2018

Rule 26 report from Dr. Rajat Dhar in Ruffino v. Archer and StoneCrest Medical Center

Opinions

When Mr. Ruffino presented to the ED with dizziness on the morning of 2/17/2016 there is no documentation that he was suffering from clear neurological deficits to suggest that he was having a confirmed or clear stroke. His neurological symptoms (primarily dizziness) had either resolved or were fluctuating. He was not triaged as an acute stroke and did not undergo a neurological assessment by a physician or midlevel provider. He did have repeatedly normal neurological assessments by the ED nurse and a normal head CT scan. Based on these facts, I do not believe that he was suffering from a clear stroke that would necessitate consideration of thrombolytic or other reperfusion therapies at that time.

After repeatedly normal neurological assessments Mr. Ruffino experienced clearly new neurological deficits during the time period from 1220-1300 that day. The ED physician, Dr. Archer, saw the patient during this time period, and a Code Stroke was appropriately activated. At this time, he had measurable and clear focal neurological deficits (including speed disturbance and right-sided weakness) that would be highly consistent with acute focal cerebral ischemia (i.e. acute stroke). It is my opinion that an acute stroke such as this should be triaged as an emergency and necessitates consideration of acute thrombolytic and reperfusion therapies.

While Dr. Archer consulted a neurologist as part of the stroke workup, both this consultation and the repeat CT scan (with CT angiography) were not obtained emergently. Moreover, it is my opinion that the timing of symptom onset during the time period from 1220-1300 was not clearly communicated between healthcare providers, such that the neurologist, Dr. Chitturi believed that the focal neurological deficits (not just dizziness) had started that morning and so Mr. Ruffino may have been outside the window for TPA. The nursing documentation of serial normal neurological assessments between 1000 and 1200 were not charted until hours after the neurologists assessment and there is no evidenced from Dr. Archer's documentation that he communicated this fact to the neurologist. It appears to be this lack of communication over the timing of the deficits that led to the presumption that he was not a candidate for TPA.

It is my opinion that the neurological deficits recognized during the 1220-1300 time period were new deficits (based on the earlier nursing neuro assessments and lack of other clear documentation of persistent neurological deficits after ED arrival) and so should not exclude him from consideration of TPA. Furthermore, even if it was unclear that fluctuating dizziness had been present on-and-off since that morning at 0830, it my opinion that this timeline does not exclude him from advanced reperfusion therapies if he developed neurological deficits during the 1220-1300 time period (just over 4 hours after initial onset). Specifically, if Mr. Ruffino had undergone an emergent CT angiogram revealing the clot in his middle cerebral artery (as he subsequently did) he would have been a candidate for endovascular thrombectomy (which would have required transfer to another facility).

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It is my opinion that should Mr. Ruffino have received TPA and/or endovascular thrombectomy for his acute stroke, he would have, more likely than not, experienced an improved neurological outcome and recovery from this stroke. He had a clear vessel occlusion and was within the time window at which both TPA and thrombectomy have shown to significantly improve outcomes after acute stroke, as has been published in peer-reviewed literature in the past few years. This type of treatment (within 4.5 hours of the onset of this type of stroke for TPA and 6 hours for thrombectomy) is effective because it provides reperfusion of blood flow to the ischemic brain and minimizes the amount of brain tissue that dies. This directly contributes to improved neurological recovery.

Facts or Data

The materials I reviewed in this matter include the medical records from StoneCrest Medical Center, the medical records from Centennial Medical Center, and the deposition testimony from Dr. Archer, Nurse Bromley, Nurse McCulloch, Mr. Ruffino, Mrs. Ruffino. The documentation in those medical records and the deposition testimony contain many of the facts referenced in this report.

At the time of the medical events in question (primarily February 17, 2016), Mr. Ruffino was a 56 year-old man. He had a history of hypertension, smoking, and obesity (i.e. several vascular risk factors). Furthermore, he had started having intermittent transient neurological events in December 2015. These events were fairly stereotypic, consisting of a combination of dizziness (not further specified) and slurred or altered speech and right body/face weakness. He had previously seen a neurologist, Dr. Efobi, for these spells, and after a work-up including MRI/MRA, had been diagnosed with possible seizures (and given gabapentin).

On the morning in question (2/17/2016), he had woken and from the best accounts we have (his own and what was told to his doctors that day, as his wife did not see him before he left for work before 0600) was initially feeling fine. It was only later that morning between 0800 and 0830 that he experienced again the sudden onset of dizziness. He denies having right-sided weakness or trouble speaking at that time. He pulled over while driving.

When he arrived at StoneCrest Hospital Emergency Department (ED) he was triaged (0956) – at which time he was noted to be hypertensive (BP 187/85) and complaining of having experienced dizziness but no other neurological symptoms. Furthermore, the triage examination documents no motor weakness (including "no drift") and no facial weakness or slurred speech (10:08am). He was not immediately triaged as an emergency or a "Code Stroke" based on his presentation, although he did have a non-contrast CT scan of the head around 10am that was read as negative for any brain pathology. The deposition of Nurse McCulloch (in triage) furthermore states her opinion that he neither complained of ongoing dizziness nor had any measurable neurological deficits concerning for a stroke. If she had been concerned about any signs or symptoms of stroke she states that she would have called a Code Stroke. It is for these reasons that he was triaged as CTAS 3 (i.e. not emergent).

Although it appears that he was assigned to the care of a NP (Mark Reinhardt), the only neurological examinations documented between 1000 and 1200 in the ED were performed by the nurse. At each of

these assessments (which included motor strength and Glasgow Coma Scale [GCS] assessment of mental status) he was judged to be neurologically normal. He does not appear to have been seen by a physician until somewhere form 1220-1300. It appears that Nurse Bromley contacted the ED physician at that time, Dr. Archer, who did come to assess Mr. Ruffino. By this time both nurse and physician document clear measurable neurological deficits including trouble speaking and right facial weakness. Dr. Archer appears to be the first provider to document a NIH Stroke Scale score, indicating a clear measurable neurological deficit (score of 4) consistent with acute stroke. A "Code Stroke" was called by these providers, recognizing the acute change in Mr. Ruffino's neurological status. There is no documentation that Mr. Ruffino had any neurological deficits prior to this time. Nurse Bromley testified that there were no neurological deficits during the multiple times Nurse Bromley performed neuro checks from 1000-1200, and that he told Dr. Archer this at or around 1300 when a neurological deficit was present.

Dr. Chitturi, a neurologist, was consulted for consideration of acute stroke therapies, including TPA. He was aware of Mr. Ruffino's prior episodes of speech difficulty and right-sided weakness (face/body) that had previously always been transient (lasting only a few minutes). He noted that this episode (with deficits persisting over one hour) was unusual compared to those, but he documented (based on information that he obtained from the other providers and/or the patient) that by the time he was contacted, the patient was outside the window for both TPA and other interventions. He concurred that Mr. Ruffino had both dysarthria (slurred speech) and expressive aphasia as well as right facial weakness (he does not note other motor weakness on his examination). Dr. Chitturi did not seem to be aware that neurological examinations (by the nurse) had found him neurologically normal from the time of triage through at least 1200 that day. Mr. Ruffino also underwent a CT angiogram which revealed a clot in his left middle cerebral artery with poor filling of the MCA territory. The neurologist opined that the patient is suffering from an acute stroke, but concluded that the stroke's onset was earlier that morning (despite the patient's neurologically normal status during the multiple times Nurse Bromley performed neuro checks from 1000-1200). By 1414, Mr. Ruffino appears to have been considered to be a non-TPA candidate based on the assessments of the ED physician and neurologist, with plans for aspirin, telemetry, and close monitoring. The results of the CTA were not called to Dr. Archer until 1512. Further neurological assessments (by the RN) show ongoing aphasia and right grip weakness. He was transferred to Centennial Medical Center later that evening. Subsequent MRI of the brain confirmed left-sided cerebral infarcts.

Qualifications

With regard to my qualifications, a copy of my CV is attached. The CV lists any publications I have authored in the past 10 years.

I was licensed to practice medicine, and practiced the specialty of Neurology, in Missouri during the 12 month period immediately prior to February 17, 2016.

My practice and experience has included assessing and treating stroke patients, including patients who had an acute stroke with an onset within 6 hours of my first contact with them.

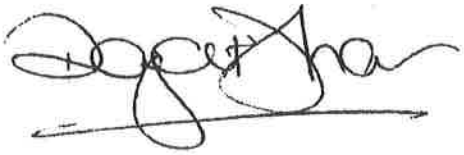
Testimony as an Expert Witness in the past four years

Washington University in St. Louis
SCHOOL OF MEDICINE
Department of Neurology

My testimony as an expert witness in the past four years, either via deposition or at a trial, is limited to two cases involving medical negligence: 1) Georgia Robertson, Conservator o/b/o Cassie McGill vs. Methodist Healthcare; 2) Tina Wesley vs. Northwest Regional Medical Center, Hunter Nelson, Dittana Phocharoensri.

Compensation as an Expert in this matter

My fees for work as an expert witness in this matter are $450.00/hour for records review, $550.00/hour for giving deposition testimony, and $4000.00/day for reserving an entire day for trial testimony. At this time, I have been paid $2400.00 for my time on this matter.



Curriculum Vitae

RAJAT DHAR

MD, FRCPC

Revised: July 25, 2016

PERSONAL INFORMATION

Date of birth:	26th October, 1976
Place of birth:	Delhi, India
Citizenship:	Canadian
Status in USA:	Permanent Resident

Contact information:

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PRESENT POSITIONS

Associate Professor
Department of Neurology
Fellowship Director;
Division of Neurocritical Care
Washington University School of Medicine in St. Louis

Attending Physician
Neurology/Neurosurgery Intensive Care Unit
Barnes-Jewish Hospital

EDUCATION

High School:	Gordonstoun School, Scotland (1990-1993) Kings-Edgehill School, Nova Scotia (1993-1994)
Undergraduate:	Bachelor of Arts & Science (1994-1997) McMaster University
Graduate:	Doctor of Medicine - **M.D.** (1997-2000) McMaster University Hamilton, Ontario, Canada.
Postgraduate:	Residency in **Neurology** (2000-2005) University of Western Ontario London Health Sciences Centre London, Ontario, Canada.
Fellowship:	**Neurological Critical Care** (2005-2007) Supervisor: Dr. Michael Diringer Washington University School of Medicine Neurology/Neurosurgery Intensive Care Unit Barnes-Jewish Hospital
Research Training	**Master of Science in Clinical Investigation** (2014-ongoing) Concentration in Genetics/Genomics Washington University in St. Louis (Clinical Research Training Center)

ACADEMIC POSITIONS

Associate Professor (2016-present)
Department of Neurology
(Division of Neurocritical Care)
Washington University School of Medicine in St. Louis

APPOINTMENTS AND COMMITTEES

University:	Washington University in St. Louis (2005-present)
Hospital:	Barnes-Jewish Hospital (2005-present)
Committees:	Stroke Center Protocol Review Committee (2010-present) Neurology Residency Program Evaluation Committee (2015-present) Transfusion Committee, Barnes-Jewish Hospital (2014-present)
External:	Executive Committee, The Organ Donation Research Consortium (2015-)
	NINDS Common Data Elements on "Cerebral Aneurysms and Subarachnoid Hemorrhage" (Assessment and Exams section)
	Program Accreditation, Physician Certification & Fellows Training (PACT) Committee, Neurocritical Care Society (2015-2019)
	Neurocritical Care Society Annual Meeting **Science Committee** (2016-)

MEDICAL LICENSURE

2001 Medical Council of Canada (inactive)
2005 Physicians and Surgeons, Missouri

BOARD CERTIFICATION

2005 Fellow of the Royal College of Physicians of Canada – FRCP(C)
(Specialization in Neurology)

2006 American Board of Psychiatry and Neurology
(Diplomate in **Neurology**)

2007 United Council for Neurological Subspecialties
(Subspecialty Certification in **Neurocritical Care**)

2009 American Board of Psychiatry and Neurology
(Diplomate in **Vascular Neurology**)

HONORS AND AWARDS

1994	Governor General's Medal / Queen Elizabeth's Medal (highest high school GPA)
1994-1997	University Scholarship / National Canada Scholarship
1995	Arts & Science 1D06 Program Award (for highest performance in Calculus)
2003-2005	Teaching Honor Roll Award of Excellence
2008	**Best Scientific Abstract** award, *Neurocritical Care Society* meeting
2009	Best Scientific Abstract award, *Association of Indian Neurologists in America*
2010	**Best Scientific Abstract** award, *Neurocritical Care Society*

Travel Fellowships:

2005	*Peripheral Nerve Society* meeting (Tuscany, Italy)
2006	Oral abstract travel award: *Neurocritical Care Society* meeting (Baltimore, MD)
2009	First *Neurocritical Care Research Conference* (Houston, TX)
2013	*ANIM 2013*; joint meeting of *German Society of Neurocritical Care* (DGNI) and *Neurocritical Care Society* (Mannheim, Germany)

EDITORIAL RESPONSIBILITIES

Ad Hoc Reviewer: (* active in past year)

*Neurocritical Care** — *European Journal of Neurology*
Neurology — *BMC Anesthesiology*
Stroke — *Expert Review of Cardiovascular Therapy*
Critical Care — *Neurology India **
*Critical Care Medicine ** — *Journal of Neurosurgical Anesthesiology **
Journal of Neurology — *European Journal of Pediatrics*
*J Critical Care ** — *Hospital Practice*
*Canadian Journal of Neurological Sciences ** *Muscle and Nerve **
*Journal of Clinical Medicine ** *Neurotherapeutics / PLOS One **
*Am J Transplantation **

Grant Reviewer: *The Stroke Association* (UK)
NIH Mock Study Section - Clinical Research Training Center, Washington University in St. Louis (2015)

Abstract Reviewer: *International Stroke Conference*, 2009-2010
Society for Critical Care Medicine Annual Congress 2009-2011, 2013-15
International Symposium on Cerebral Blood Flow, Metabolism and Function – Brain 2015.

PROFESSIONAL ORGANIZATIONS

Neurocritical Care Society (2003-present)
Society of Critical Care Medicine (2007-2012)
American Heart Association, Stroke Council (2009-present)
International Society for Cerebral Blood Flow and Metabolism (2011-present)
Organ Donation Research Consortium (2012-present)
- member of the *Executive Committee* (2015-present)

CONSULTING RELATIONSHIPS AND BOARD MEMBERSHIPS

Associate Medical Director (Donor Management)
Mid-America Transplant

INVITED PROFESSORSHIPS AND LECTURESHIPS

2004 Blood Pressure: The Ups and Downs
- Series of primary care workshops sponsored by *Heart & Stroke Foundation of Ontario*

2006 Brain, Blood, and the Body: Systemic effects of Subarachnoid Hemorrhage
- Invited lecture at *University of Western Ontario (London Health Science s Centre*)

2007 Cool Trends across the Stroke Continuum
- Plenary session at the *National Stroke Association* regional meeting, St. Louis

2008 The State of the Art of Neurocritical Care
- At the 26th annual *Southern Illinois University* (SIU) Neurology Symposium

2008- Ventilation of the Neurologic Patient

- Invited speaker at Respiratory Critical Care Lecture Series, Barnes-Jewish Hospital

2008 The ICU Management of Intracranial Hemorrhage
- Invited speaker at "First Annual Stroke Conference: Stroke from A-Z" in Springfield, MO

2008 The Role of Red Blood Cell Transfusion in Preventing Ischemia after SAH.
- Speaker at Washington University *Stroke Conference*

2008 Hyponatremia in the Neurointensive Care Unit: Causes, Concerns, and Correction.
- Invited speaker at Astellas Pharma Scientific Affairs Cardiovascular Meeting, Denver

2009 To Clip or Coil Ruptured Cerebral Aneurysms? That is the Question.
- Invited speaker at *American Academy of Neurology* annual meeting, Seattle.
(Educational course on "Critical Care of Brain Hemorrhage")

2010- Evidence-Based Prevention and Treatment of Neurological Complications after Acute Ischemic Stroke.
- Speaker in the *William Powers Evidence-Based Lecture* series at Washington University.

2010- Neurological Examination of the Comatose Patient.
- Speaker at *Comprehensive Brain Anatomy & Neurological Assessment* workshops; Saint Louis University School of Medicine, Practical Anatomy & Surgical Education

2011- Intracerebral and Subarachnoid Hemorrhage
- Department of Neurology *Clinical Neuroscience* lecture series, Washington University

2012- Seizures and Status Epilepticus; Neuromuscular Respiratory Failure
- Multidisciplinary Critical Care Conference, Washington University School of Medicine

2012 What is the Ideal Hemoglobin for Patients with Subarachnoid Hemorrhage?
- Invited speaker to the Annual Congress of the *Canadian Neurological Sciences Federation*, Ottawa (Neurocritical Care symposium)

2012 Vasospasm and Cerebral Ischemia after Subarachnoid Hemorrhage: An Evolution
- Speaker at Department of Neurology Grand Rounds, Washington University in St. Louis

2013 Correlation between Angiographic Vasospasm, Cerebral Blood Flow, and Infarction.

- Plenary speaker at the 12th International Conference on Neurovascular Events after Subarachnoid Hemorrhage (Vasospasm 2013), Lucerne, Switzerland

2013 Management of Malignant Hemispheric Stroke
- Invited speaker at the Department of Neurology Grand Rounds, Saint Louis University

2014 Drugs after Brain Death
- Faculty speaker at the Neuropharmacology Workshop, annual meeting of the *Neurocritical Care Society*

2014 Kinetics of Cerebral Edema after Large Hemispheric Stroke: A Quantitative Endophenotype for Genetic Studies
- Hope Center: Neurovascular Injury and Repair speaker series

2015 Safety of PEGylated Carboxyhemoglobin Bovine (Sanguinate) Infusion in Patients at Risk for Delayed Cerebral Ischemia after Subarachnoid Hemorrhage
- Vasospasm 2015 (13th International Conference on Neurovascular Events after SAH)

2016 Interactions of the Heart and Brain in Critical Care
- Invited speaker at Grand Rounds for the Cardiology Division, Victoria Hospitals, BC

2016 Seizures and Inflammation in SAH.
- Invited speaker at the Fourth Neurocritical Care Research Conference, Houston

2016 The Toxic Milieu: Hemodynamic Changes of Brain Death – to be given at the: Organ Donor Management Symposium at the *American Transplant Congress* 2016

CURRENT RESEARCH SUPPORT

Governmental:

Award:	**KL2 Career Development Award** (5KL2TR000450-08)
Role:	Principal Investigator (Mentors: Jin-Moo Lee, MD, PhD; Carlos Cruchaga, PhD)
Source:	National Institutes of Health (Washington University)
Title:	The genetics of cerebral edema after large hemispheric stroke
Dates:	12/1/2014-11/31/2016

Non-Governmental / Clinical Trials:

Role:	Principal investigator
Title:	Single-dose, Open-label Study to Assess the Safety and Effect of SANGUINATE™ Infusion in Patients at Risk of Delayed Cerebral Ischemia (DCI) after Acute Aneurysmal Subarachnoid Hemorrhage (SAH) – SGCI-002
Study Type:	Phase IIa (Biomarker: PET imaging of cerebral metabolism)
Source:	Prolong Pharmaceuticals

PREVIOUS RESEARCH SUPPORT

Award:	**Scientist Development Grant** (10SDG3440008)
Role:	Principal Investigator (Mentor: Michael Diringer, MD)
Source:	**American Heart Association** (National Program)
Title:	The role of transfusion in optimizing cerebral oxygen delivery and preventing ischemia after subarachnoid hemorrhage
Dates:	7/1/2010-6/30/2014 (no-cost extension till 2015)
Amount:	$308,000

Award:	Program Project Grant ("Clinical pathophysiology of acute brain injury")
Role:	Co-Investigator
Source:	NIH/NINDS (5P50NS035966-10)
Title:	Physiologic response to osmotic treatments in patients with brain edema
Dates:	6/1/2009-5/31/2011

Award:	Foundation grant
Role:	Investigator (supervised by Dr. M. Diringer)
Source:	Barnes-Jewish Hospital Foundation
Title:	Effect of Red Cell Transfusion on Brain Metabolism in Patients with Subarachnoid Hemorrhage
Dates:	October 1, 2007 to September 30, 2009
Amount:	$99,000 /yr (x 2 years)

Award:	Research stipend
Role:	Primary Investigator (supervised by Dr. A. Hahn)
Source:	Bayer Canada
Title:	The morbidity and outcomes of patients with Guillain-Barré Syndrome admitted to the intensive care unit
Dates:	2003-2005

Amount: $4,000

Award: Medical student summer research project award
Role: Investigator (supervised by Dr. M. Mazurek)
Source: Medical Research Council (MRC) of Canada
Title: Experimental study of mitochondrial dysfunction from antipsychotic drugs
Dates: Summer 1999
Amount: $3,500

ADMINISTRATIVE EXPERIENCE

Fellowship Director (Neurocritical Care): 2013-
Program director of UNCS-accredited training program in neurologic intensive care at Washington University in St. Louis (2 fellows per year x 2 years).

ICU Database Manager
Created and responsible for maintaining an ICU quality and research database (IQARIS)

Chief Resident in Neurology:
Responsible for organizing weekly resident teaching and preparing bimonthly slide review sessions on imaging and neuropathology (2003-2004).

***Canadian Stroke Consortium's* Annual Stroke Review Course for Neurology Residents**:
National resident representative on the SCS committee planning the annual review course for Canadian neurology residents, held in Toronto, March 26-28, 2004. Presented a workshop on "Unusual Causes of Stroke" at this course.

Cerebrovascular Diseases Curriculum:
Assisted in the preparation of a curriculum for neurology residents for a new rotation in cerebrovascular diseases, at the *University of Western Ontario* (2002).

Secondary Stroke Prevention Committee:
Resident representative on a multi-disciplinary committee convened to create and modify in-patient protocols for all facets of stroke care, specifically addressing secondary prevention in an evidence-based model. Created critically-appraised review of evidence for smoking cessation. Initiated review of existing stroke admission protocols and created a new protocol (2002).

TEACHING EXPERIENCE

Course Master: Neuro-ICU Clerkship Elective, Washington University in St. Louis (2014-)

Neurological Emergencies Seminars:
Created and organized an annual series of six case-based, discussion-oriented small-group seminars for final year medical students, covering the major emergencies in neurology and neurosurgery. Prepared illustrative cases for each topic, collected relevant teaching material for students and facilitators, and compiled series of teaching slides (2001-2005).

Neurological Medicine On-line Pocketbook:
Founding senior editor of a novel, dynamic, web-based initiative to provide a concise and up-to-date resource for residents on neurology rotations, including approaches to major neurological conditions and instructive images and diagrams (2002-2005).

Clinical Skills in Neurology:
Guided small-group sessions teaching the neurological emergencies to both first- and second-year medical students. Assessor for OSCE testing in neurological examination (2003-2005).

CURRENT RESEARCH INTERESTS

1. Genomics, pathophysiology and kinetics of cerebral edema after ischemic stroke
2. Anemia and red blood cell transfusion in subarachnoid hemorrhage
3. Relationship of vasospasm to cerebral perfusion and oxygen delivery.
4. Inflammatory response after acute brain injury (including subarachnoid hemorrhage)
5. Management of hyponatremia and cerebral edema in the neurointensive care unit
6. Hypothermia for treatment of status epilepticus
7. Optimizing management of brain-dead organ donors prior to transplantation

Research Skills

- Data/Statistical software: Excel, SPSS, R
- Database creation: Access, REDCap (online)

BIBLIOGRAPHY

ORCID ID/0000-0002-5167-5097

PEER-REVIEWED PUBLICATIONS

1. **Dhar R**, Duke RJ, Sealey BJ. Cough syncope from constrictive pericarditis: a case report. *Can J Cardiol* 2003; 19: 295-296.

2. Tellez-Zenteno JF, **Dhar R**, Wiebe S. Long-term seizure outcomes following epilepsy surgery: a systematic review and meta-analysis. *Brain* 2005; 128: 1188-1198.

3. Tellez-Zenteno JF, **Dhar R**, Hernandez-Ronquillo L, Wiebe S. Long-term outcomes in epilepsy surgery: antiepileptic drugs, mortality, cognitive and psychosocial aspects. *Brain* 2007; 130: 334-345.

4. **Dhar R**, Stitt L, Hahn AF. The morbidity and outcome of patients with Guillain-Barré syndrome admitted to the intensive care unit. *J Neurol Sci* 2008; 264: 121-128.

5. **Dhar R**, Young GB, Marotta P. Perioperative neurological complications after liver transplantation are best predicted by pre-transplant hepatic encephalopathy. *Neurocrit Care* 2008; 8: 253-258.

6. **Dhar R**, Diringer MN. The burden of the systemic inflammatory response predicts vasospasm and outcome after subarachnoid hemorrhage. *Neurocrit Care* 2008; 8: 404-412.

7. Keyrouz SG, **Dhar R**, Axelrod YK. Call-Fleming syndrome and orgasmic cephalgia. *Headache* 2008; 48(6): 967-971.

8. Corry JJ, **Dhar R**, Murphy T, Diringer MN. Hypothermia for refractory status epilepticus. *Neurocrit Care* 2008, 9(2): 189-197.

9. Keyrouz SG, **Dhar R**, Diringer MN. Variation in osmotic response to sustained mannitol administration. *Neurocrit Care* 2008, 9(2): 204-209.

10. Murphy T, **Dhar R**, Diringer MN. Conivaptan bolus dosing for the correction of hyponatremia in the neurointensive care unit. *Neurocrit Care* 2009; 11(1): 14-19.

11. **Dhar R**, Zazulia AR, Videen TO, Zipfel GJ, Derdeyn CP, Diringer MN. Red blood cell transfusion increases cerebral oxygen delivery in patients with anemia after subarachnoid hemorrhage. *Stroke* 2009; 40: 3039-44.

12. Sampson T, **Dhar R**, Diringer MN. Factors associated with the development of anemia after subarachnoid hemorrhage. *Neurocrit Care* 2010; 12(1):4-9.

13. **Dhar R**, Human T. A bolus of conivaptan lowers intracranial pressure in a patient with hyponatremia after traumatic brain injury. *Neurocrit Care* 2011; 14: 97-102.

14. Murphy-Human T, Welch E, Zipfel G, Diringer M, **Dhar R**. Comparison of short-duration levetiracetam to extended-course phenytoin for seizure prophylaxis following subarachnoid hemorrhage. *World Neurosurg* 2011; 75: 269-74.

15. Diringer MN, Scalfani MT, Zazulia AR, Videen TO, **Dhar R**. Cerebral hemodynamic and metabolic effects of equi-osmolar doses of mannitol and 23.4% saline in patients with edema following large ischemic stroke. *Neurocrit Care* 2011; 14:11-17.

16. Sampson T, **Dhar R**, Zipfel G. Cerebral infarction following a seizure in a patient with subarachnoid hemorrhage complicated by delayed cerebral ischemia. *Surg Neurol Int* 2011; 2:14.

17. **Dhar R**, Dacey R, Human T, Zipfel G. Unilateral posterior reversible encephalopathy syndrome with hypertensive therapy of contralateral vasospasm. *Neurosurgery* 2011; 69(5):E1176-81.

18. **Dhar R**, Scalfani MT, Zazulia AR, Videen TO, Derdeyn CP, Diringer MN. Comparison of induced hypertension, fluid bolus, and blood transfusion to augment cerebral oxygen delivery after subarachnoid hemorrhage. *J Neurosurg* 2012; 116(3):648-56.

19. Scalfani MT, **Dhar R**, Zazulia AR, Videen TO, Diringer MN. Effect of osmotic agents on cerebral blood flow in traumatic brain injury. J *Crit Care* 2012; 27(5):526.e7-12.

20. Diringer M, Scalfani M, Zazulia A, Videen T, **Dhar R**, Powers W. Effect of mannitol on cerebral blood volume in patients with head injury. *Neurosurgery* 2012; 70: 1215-8.

21. Kumar A, Keyrouz S, Willie T, **Dhar R**. Reversible obstructive hydrocephalus from hypertensive encephalopathy. *Neurocrit Care* 2012; 16(3): 433-39.

22. **Dhar R**, Scalfani MT, Blackburn S, Zazulia AR, Videen T, Diringer M. Relationship between angiographic vasospasm and regional hypoperfusion in aneurysmal subarachnoid hemorrhage. *Stroke* 2012; 43: 1788-94.

23. Human T, Onuoha A, Diringer M, **Dhar R.** Response to a bolus of conivaptan in patients with acute hyponatremia after brain injury. *J Crit Care* 2012; 27(6):745.e1-5.

24. **Dhar R,** Cotton C, Coleman J, Brockmeier D, Kappel D, Marklin G, Wright R. Comparison of high- and low-dose corticosteroid regimens for organ donor management. *J Crit Care* 2013; 28(1):111.e1-7.

25. Brown R, Kumar A, **Dhar R,** Sampson TR, Diringer MN. Relationship between delayed infarcts and angiographic vasospasm after aneurysmal subarachnoid hemorrhage. *Neurosurery* 2013; 72: 702-8.

26. Kumar A, Brown R, **Dhar R,** Sampson T, Derdeyn CP, Moran CJ, Diringer MN. Early vs. delayed cerebral infarction following aneurysm repair after subarachnoid hemorrhage. *Neurosurgery* 2013; 73: 617-23.

27. Rubin M, **Dhar R,** Diringer M. Racial differences in withdrawal of mechanical ventilation do not alter mortality in neurologically injured patients. *J Crit Care* 2014; 29: 49-53.

28. Raya A, Zipfel G, Diringer M, Dacey R, Derdeyn C, Rich K, Chicoine M, **Dhar R.** Pattern not volume of bleeding predicts angiographic vasospasm in non-aneurysmal subarachnoid hemorrhage. *Stroke* 2014; 45: 265-67.

29. Washington CW, Derdeyn CP, Dacey RG, **Dhar R,** Zipfel GJ. Analysis of subarachnoid hemorrhage using the Nationwide Inpatient Sample: the NIS-SAH severity score and NIS-SAH outcome measure. *J Neurosurg* 2014; 121:482-9.

30. Bussiere M, Gupta M, Sharma M, Dowlatshahi D, Fang J, **Dhar R.** Anaemia on admission is associated with more severe intracerebral hemorrhage and worse outcomes. *Int J Stroke* 2015; 10: 382-7.

31. Kumar A, Cage A, **Dhar R.** Dialysis-induced worsening of cerebral edema in intracranial hemorrhage: a case series and clinical perspective. *Neurocrit Care*; 2015; 22: 283-7.

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H-index: 13
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ABSTRACTS: PLATFORMS AND POSTERS

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44. **Dhar R**, Washington CW, Diringer MN, Derdeyn CP, Zipfel GJ. Acute effect of intravenous sildenafil on cerebral blood flow in patients with vasospasm after subarachnoid hemorrhage [Poster]. Presented at the XXVIIth International Symposium on Cerebral Blood Flow, Metabolism, and Function, 2015.

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48. Arshi B, Diringer M, **Dhar R**. Variability in training in endotracheal intubations among neurocritical care fellowship programs [Poster] presented at the *Neurocritical Care Society* annual meeting, 2015.

49. Roberts D, **Dhar R**. Impact of obesity (weight) on pulmonary embolism risk and prophylaxis dosing [Poster] presented at the *Neurocritical Care Society* annual meeting, 2015.

50. Roy B, McCullough L, Dhar R, Grady J, Wang Y, Brown RJ. Phenyleprhine vs. norepinephrine as the initial vasopressor in the management of delayed cerebral ischemia. [Poster] presented at the *Neurocritical Care Society* annual meeting, 2015.

51. Chen Y, Dhar R, et al. Validation of an efficient machine-learning approach to quantify CSF volume changes using multicenter CT scans [Moderated Poster] to be presented at the *International Stroke Conference* 2016.

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53. Human T, Diringer M, Allen M, Chicoine M, Zipfel G, Dacey R, **Dhar R**. Duration of seizure prophylaxis after subarachnoid hemorrhage (DOPAST): Results of a randomized clinical trial. [Poster] to be presented at *Neurocritical Care Society* 2016 meeting.

54. **Dhar R**, Yuan K, Kulik T, Chen Y, Lee JM. CSF volumetrics to model early kinetics of malignant cerebral edema after large hemispheric infarction. [Poster] to be presented at *Neurocritical Care Society* 2016 meeting.

55. Ong C, Gluckstein J, Laurido-Soto O, **Dhar R**, Lee JM. Added value of imaging characteristics at 12-36 hours in predicting potentially lethal malignant edema. [Poster] to be presented at the American Neurological Association meeting 2016.

56. Ramiro R, **Dhar R**, Feen E, Kumar A. Improvement in midline shift is associated with survival after decompressive hemicraniectomy in large hemispheric infarctions. [Poster] to be presented at the American Neurological Association meeting 2016.

[29 presented as first or last author]